Lassonde School of Engineering
Department of Earth and Space Science and Engineering
Geomatics Engineering

LE/ESSE 4650 – Hydrography
Winter 2022

LAB # 1: Underwater Acoustics (100)

Assigned: **January 14, 2022**
Due: **January 28, 2022**

Objective:
The objective of this lab is to acquaint students with elements of oceanography and concepts and underwater acoustics which are used in Hydrography.

Tasks: Please answer all questions

Question 1 (20)
1.1) You collected 450 grams of seawater. It was left outside a few hours and the water evaporated. Some salt sediments were found at the base of the container which was used to collect the seawater and found to have a mass of 25 grams. Determine the salinity of the seawater?
1.2) At a habour site in Western Canada, a CTD probe was used to measure the salinity of the nearby water as 18 ppt. Compute the mass of salted minerals dissolved in 2200 grams of seawater.

Question 2 (20)
A sound wave propagating at 9.50 Hz has a velocity of 0.860 m/s in a shallow region of seawater. The wave enters a deeper portion of water and has a resultant angle of 41° between the transmitted direction of the wave and the plane separating the two water mediums. Using the provided values, determine the following:
2.1) an expression for the angle formed between the plane and the incident wave direction.
2.2) an expression for the wavelength of the sound wave in deep water.

Question 3 (20)
You collected temperature and salinity data off the coast at a survey site in Newfoundland at different sea depths. This data is shown in Table 1 below:

Table 1. Temperature and Salinity data collected at varying underwater depths.

Temperature (°C)	Salinity (ppt)	Depth (m)
34.26	**31.67**	**0**
34.26	**33.46**	**10**
34.26	**33.46**	**20**

34.2	**33.2**	**85**
33.35	**33.02**	**150**
32.25	**32.87**	**175**
31.43	**32.69**	**300**
31.39	**32.47**	**550**
31.14	**31.33**	**725**
27.49	**30.28**	**1150**
25.53	**30.04**	**1200**
21.88	**31.15**	**1500**
21.85	**31.08**	**2000**

3.1) Create and plot two profiles (one salinity profile and one temperature profile) against the variation in depth. (Note: use appropriate coordinate axis limits to properly visualize the profiles).
3.2) On each respective profile, label the thermocline and halocline regions.
3.3) Comment on what you observe for each profile pertaining to the relation of depth.

Question 4 (20)
4.1) Using the data in Table 1, compute the speed of sound in water for each instance of temperature, salinity and depth. Briefly explain and justify which empirical formulae you used to compute this speed of sound. (Note: provide results in tabular format).
4.2) Generate a sound speed profile using the computed values in 4.1.
4.3) Compute the average sound speed and provide a brief justification for your approach.

Question 5 (20)
The SONAR equation is useful in understanding acoustic system parameters. Using resources from textbooks, websites and journal articles, in your own words, discuss each of the various components which make up the SONAR equations and their impact on target detection from echo sounders.

Submission of lab report
The lab report must address each question, describe the steps of the work, and provide the findings and answers for each question. The lab report should include: description and explanations of the details of the steps and mathematical expressions/formulae used, programming flow charts and pseudo code, programming code, illustration of computations and results obtained. Citations/references must be provided when using external sources (e.g., books, web, journal papers) for research. Digital versions of the report are to be submitted. Make sure to reference your sources. Use appendices when necessary. Include title page and scope of this exercise. It must be a professional report. Pay attention to structure, syntax, grammar, spelling and presentation. All code/scripts created and used should also be included in the submitted reports.